ESA 105-2_Wisconsin Food Processing Facility
Steam ESA – Public Report - Final

Company	Wisconsin Food Processing Facility	**ESA Dates**	June 6th to 8th
Plant	South Central Wisconsin	**ESA Type**	Steam
Product	Food Products	**ESA Specialist**	Tom Tucker, P.E.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA provided through the United States Department of Energy-Energy Savings Now initiative, which was started to help the largest natural gas users in the United States identify ways to reduce energy use.

Note: to protect the confidentiality, potentially sensitive information related to energy cost savings, operational data and references to the facility has been removed.

Steam System
There are two (2) gas fired boilers on site that were once fired primarily by coal. Superheated steam is generated at approximately 425-psig (675°F) and fed to an extraction/back pressure turbine. Steam is extracted at 60-psig for process use and exhausted at approximately 12-psig for use at 5-psig to heat water. The isentropic efficiency of the turbine sections was checked.

The #5 boiler is the primary boiler at present. The efficiency of the boiler was checked with a combustion analyzer. However, waste heat from the exhaust is recovered in an economizer and used to preheat feed water from approximately 224°F to 310°F, providing an efficiency gain of approximately 6-percent.

Objective of ESA:
The primary objective of the ESA was to identify steam cost reduction opportunities and to have the primary ESA lead become comfortable with the concepts behind use of the DOE steam tools. Particular attention was given to the Steam System Assessment Tool (SSAT), although the use of 3E Plus (v3.2) was also demonstrated to address insulation related projects.

Focus of Assessment:
SSAT was applied to model cost reduction opportunities identified during walk-throughs and group discussions. The majority of the effort was spent in the power house. However, the process areas were briefly reviewed and a number of steam cost reduction opportunities were identified and evaluated. These include insulation and reducing unnecessary waste of hot water. Other opportunities already being considered, such as the heat recovery from afterburners, were not evaluated.

Approach for ESA:
The ESA started with an introduction and a brief Power Point presentation introducing the different steam tools. The Steam System Scoping Tool (SSST) was completed during the assessment.

General Observations of Potential Opportunities:
Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. <u>Near term opportunities</u>: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.

2. Medium term opportunities: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. Long term opportunities: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

1. Reduce Steam Demand – Use Condensing Exhaust Heat Recovery to Preheat Facility Water (medium term)
Condensing heat recovery (CHR) systems are designed to allow boiler exhaust to be cooled to a much lower temperature (90°F to 130°F) than is possible with a "standard" economizer such as the one on boiler #5. The benefit is that the water vapor present in the exhaust from fuel combustion contains 8 to 10-percent of the fuel energy input to the boiler. This "latent" heat is not available until the vapor begins to condense at approximately 135°F (stack temperatures from CHR systems commonly range from 90°F to 130°F). Usually about 50-percent of the latent heat can be removed and this is assumed to develop the savings estimate. There is about 1-lb water vapor formed for each 10,000-Btu of gas burned.

Because standard economizers are not designed to handle corrosive condensate products they are limited to lower exhaust temperatures of 250°F to 325°F depending on the fuel. Condensing heaters of any type work best when the entering water is cold, such as the 55°F city water used at the plant.

There must be a good use for heat for any waste heat recovery project to be viable.

1. Investigate Options for Lowering Exhaust Oxygen (medium term)
High levels of oxygen in boiler exhaust indicate a greater percentage of excess air than is normally required to provide good fuel combustion, removes heat from the boiler and reduces efficiency.

While the boiler presently uses natural gas, investigation revealed that there is an over fire air fan remaining from the time when the boiler was fired with coal. Apparently the gas burners are oversized and over a specific steam load, the rear of the boiler becomes too hot so the over fire air fan is used to keep the rear of the boiler cool. The correct oxygen level can likely be obtained by replacement of the burners and controls if the boilers are to be kept. Some benefit may also be obtained from tuning, since it is uncertain when the last tuning was performed.

2. Increase Boiler Efficiency: Recover Sensible Heat from Boiler Blowdown (medium term)
The current boiler configuration includes flash steam recovery to the LP header from blowdown but does not include a heat exchanger to recover the remaining sensible heat. As a result hot water (~244°F) is sent to drain. This water has value for makeup water heating.

However, a preliminary engineering analysis conducted after the assessment on the performance of the heat exchanger indicates that a single shell and tube unit would not be feasible due to a phenomenon called "temperature cross." A plate and frame exchanger could work but is not recommended by Kinergetics for blow down service because a welded type would be required (due to the high pressure) and would be difficult to clean.

A realistic savings estimate places the final blowdown temperature at approximately 93°F (not 75°F as the model specifies). The simple return is expected to be less than one year. This project is recommended for implementation.

3. Recover Condensate – Prevent Condensate Dumping Due to Plate and Frame Gasket Failures (medium term)
Water is presently heated using 5-psig steam in plate and frame heat exchangers. The exchangers were originally specified based on saturated steam, not the superheated steam that is actually present. High temperature gasket materials are now being used with some success but it appears that the temperature of the steam is still greater than the rating of the gasket material.

When failure does occur, a significant amount of heat can be lost since the condensate cannot be recovered.

Additionally, there is the potential for downtime if several heat exchangers fail at once because the available supply of hot water may not meet demand.

One effective solution is to install a desuperheating station for the 5-psig steam. The savings for this opportunity is related to preventing loss of condensate, the cost of the gasket materials since low temperature gaskets could then be used, and reducing the risk of downtime.

Notes:
1. This estimate does *not* include any production downtime.
2. Preliminary station design indicates a straight run pipe length of approximately 15 to 25-feet, with temperature sensing at about 45-feet from the station.

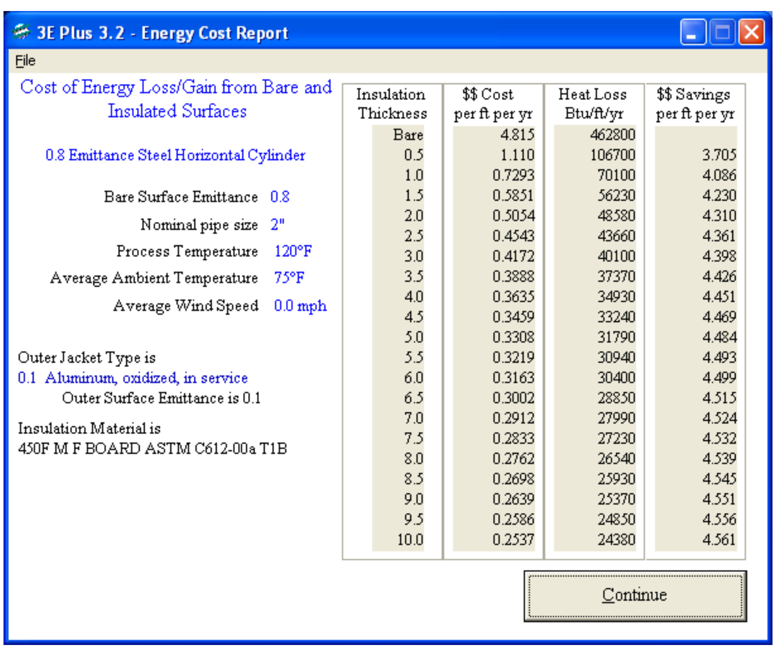
4. Reduce Steam Demand – Minimize Waste of Hot Water (near term)
During the assessment a brief tour of the process areas was provided, with several areas where hot water is "wasted" being noted. These are the food conveyor chain washer overflow (~10-gpm, possibly due to a failed level control valve) and where hot water was being used to wash hand tools (~2-gpm) in a stainless steel container.

The nature of the overflow on the food conveyor washer indicates that overflow likely occurs all of the time. The temperature was estimated at approximately 110°F. The loss of hot wash water for tool washing appears to be either related to a failed level control valve or lack of employee awareness. In either case the simple return should be nearly immediate. This is recommended for further consideration as appropriate.

5. Reduce Steam Demand – Minimize DA Venting (near term)
The vent on the DA tank allows proper removal of dissolved oxygen and other gases from boiler feedwater to protect the boiler and other components of the steam system from pitting or corrosion damage. Generally, the venting rate is approximately 1/10 of one percent of the design steam capacity.

Notes:
1. As a guide, a 2-inch free space over the vent and a plume approximately 2 to 3-feet high are good targets.
2. The chemical use should be monitored for changes that indicate increased oxygen levels. See your chemical service provider for more information.

6. Improve Insulation (near term)
With natural gas at $8.53 per million Btu any pipe 2-inches in diameter or greater with a surface temperature greater than 120°F should be insulated. The screen shot below is a 3EPlus model run that shows the cost savings possible when insulating 2-inch pipe with a surface temperature of 120°F. If a reasonably large quantity of insulation is required, the installed cost of insulation for this pipe is estimated at $6 to $10 per lineal foot. The simple return would range from 2 to 2.5 years.


3E Plus 3.2 - Energy Cost Report

File

Cost of Energy Loss/Gain from Bare and Insulated Surfaces

0.8 Emittance Steel Horizontal Cylinder

Bare Surface Emittance 0.8
Nominal pipe size 2"
Process Temperature 120°F
Average Ambient Temperature 75°F
Average Wind Speed 0.0 mph

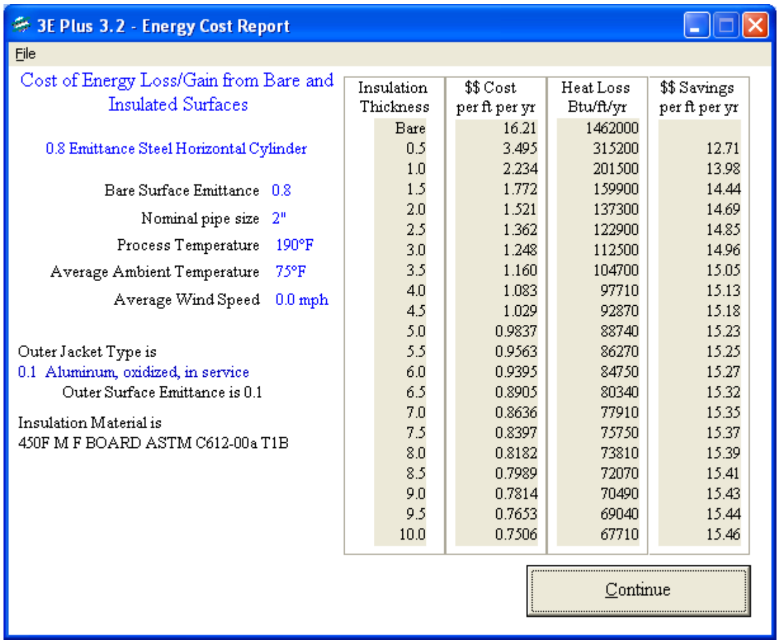
Outer Jacket Type is
0.1 Aluminum, oxidized, in service
Outer Surface Emittance is 0.1

Insulation Material is
450F M F BOARD ASTM C612-00a T1B

Insulation Thickness	$$ Cost per ft per yr	Heat Loss Btu/ft/yr	$$ Savings per ft per yr
Bare	4.815	462800	
0.5	1.110	106700	3.705
1.0	0.7293	70100	4.086
1.5	0.5851	56230	4.230
2.0	0.5054	48580	4.310
2.5	0.4543	43660	4.361
3.0	0.4172	40100	4.398
3.5	0.3888	37370	4.426
4.0	0.3635	34930	4.451
4.5	0.3459	33240	4.469
5.0	0.3308	31790	4.484
5.5	0.3219	30940	4.493
6.0	0.3163	30400	4.499
6.5	0.3002	28850	4.515
7.0	0.2912	27990	4.524
7.5	0.2833	27230	4.532
8.0	0.2762	26540	4.539
8.5	0.2698	25930	4.545
9.0	0.2639	25370	4.551
9.5	0.2586	24850	4.556
10.0	0.2537	24380	4.561

Continue

The screen shot below shows the value of insulating the 2-inch diameter condensate pipe identified as missing insulation in the process area basement. At a temperature of 190°F and assuming that there is a reasonable amount of insulation to be installed the insulation cost is approximately $10 per lineal foot. At this price the simple return is approximately 1.5 years.



3E Plus 3.2 - Energy Cost Report

File

Cost of Energy Loss/Gain from Bare and Insulated Surfaces

0.8 Emittance Steel Horizontal Cylinder

Bare Surface Emittance 0.8

Nominal pipe size 2"

Process Temperature 190°F

Average Ambient Temperature 75°F

Average Wind Speed 0.0 mph

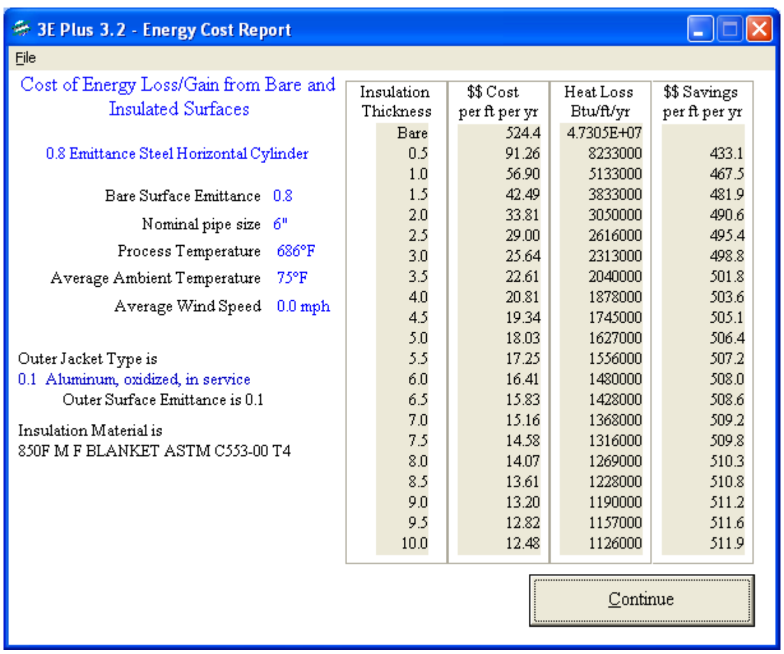
Outer Jacket Type is
0.1 Aluminum, oxidized, in service
Outer Surface Emittance is 0.1

Insulation Material is
450F M F BOARD ASTM C612-00a T1B

Insulation Thickness	$$ Cost per ft per yr	Heat Loss Btu/ft/yr	$$ Savings per ft per yr
Bare	16.21	1462000	
0.5	3.495	315200	12.71
1.0	2.234	201500	13.98
1.5	1.772	159900	14.44
2.0	1.521	137300	14.69
2.5	1.362	122900	14.85
3.0	1.248	112500	14.96
3.5	1.160	104700	15.05
4.0	1.083	97710	15.13
4.5	1.029	92870	15.18
5.0	0.9837	88740	15.23
5.5	0.9563	86270	15.25
6.0	0.9395	84750	15.27
6.5	0.8905	80340	15.32
7.0	0.8636	77910	15.35
7.5	0.8397	75750	15.37
8.0	0.8182	73810	15.39
8.5	0.7989	72070	15.41
9.0	0.7814	70490	15.43
9.5	0.7653	69040	15.44
10.0	0.7506	67710	15.46

Continue

The screen shot below shows the value of insulating 6-inch diameter *steam* pipe. This is equivalent to the section of pipe in the boiler house in front of the control panel near the turbine (the diameter is estimated). The annual savings is approximately $1,990. The best means of insulation in this case is a removable blanket to allow maintenance of the orifice plates in the section of pipe. The simple return is approximately 6 months to one year.



3E Plus 3.2 - Energy Cost Report

File

Cost of Energy Loss/Gain from Bare and Insulated Surfaces

0.8 Emittance Steel Horizontal Cylinder

Bare Surface Emittance 0.8

Nominal pipe size 6"

Process Temperature 686°F

Average Ambient Temperature 75°F

Average Wind Speed 0.0 mph

Outer Jacket Type is
0.1 Aluminum, oxidized, in service
Outer Surface Emittance is 0.1

Insulation Material is
850F M F BLANKET ASTM C553-00 T4

Insulation Thickness	$$ Cost per ft per yr	Heat Loss Btu/ft/yr	$$ Savings per ft per yr
Bare	524.4	4.7305E+07	
0.5	91.26	8233000	433.1
1.0	56.90	5133000	467.5
1.5	42.49	3833000	481.9
2.0	33.81	3050000	490.6
2.5	29.00	2616000	495.4
3.0	25.64	2313000	498.8
3.5	22.61	2040000	501.8
4.0	20.81	1878000	503.6
4.5	19.34	1745000	505.1
5.0	18.03	1627000	506.4
5.5	17.25	1556000	507.2
6.0	16.41	1480000	508.0
6.5	15.83	1428000	508.6
7.0	15.16	1368000	509.2
7.5	14.58	1316000	509.8
8.0	14.07	1269000	510.3
8.5	13.61	1228000	510.8
9.0	13.20	1190000	511.2
9.5	12.82	1157000	511.6
10.0	12.48	1126000	511.9

Continue

Valves and regulators such as those in the boiler room, heat exchangers and flash tanks are also areas worthy of insulation. These can be also insulated with “removable” insulation to allow maintenance when necessary. Removable insulation is more expensive than standard pipe insulation (per foot) but is cost effective. The simple return for installing removable insulation on 2, 4, and 6-inch steam valves is expected to be approximately one year.

Notes:

1. It is recommended that all condensate return and steam supply piping be insulated. The only exception is on the cooling leg of thermostatic steam traps, since these traps rely on condensate subcooling to function properly. Generally, insulation projects can be considered a “just do it” type projects, with no need to estimate savings since the return will be on the order of one year or less.

Management Support and Comments:
Generally, the initial feedback from the ESA group was favorable. Overall the group was very engaged and interested in applying the models to help screen cost reduction opportunities.